weight, could produce beneficial results. But the addition in more than 0.25 percent by weight would not be so effective as hoped from the quantity added. Rather, that would reduce the hot forgeability and extrudability.

[0029] As with phosphorus, antimony and arsenic in a very small quantity - 0.02 or more percent by weight - are effective in improving the de-zincification corrosion resistance and other properties. But their addition exceeding 0.15 percent by weight would not produce results in proportion to the excess quantity added. Rather, it would affect the hot forgeability and extrudability as does phosphorus applied in excessive amounts.

[0030] Those observations indicate that the fifth invention alloy is improved in machinability and also corrosion resistance and other properties by adding at least one element selected from among phosphorus, antimony, and arsenic (which improve corrosion resistance) in quantities within the aforesaid limits in addition to the same quantities of copper and silicon as in the first invention copper alloy. In the fifth invention alloy, the additions of copper and silicon are set at 69 to 79 percent by weight and 2.0 to 4.0 percent by weight respectively - the same level as in the first invention alloy in which any other machinability improver than silicon and a small amount of lead is not added - because phosphorus works mainly as a corrosion resistance improver like antimony and arsenic.

[0031] A free-cutting copper alloy also with an excellent easy-to-cut feature and with a high corrosion resistance which is composed of 69 to 79 percent, by weight, of copper; 2.0 to 4.0 percent, by weight, of silicon; 0.02 to 0.4 percent, by weight, of lead; at least one element selected from among 0.02 to 0.25 percent, by weight, of phosphorus, 0.02 to 0.15 percent, by weight, of antimony, and 0.02 to 0.15 percent, by weight, of arsenic; one element selected from among 0.02 to 0.4 percent, by weight,

of bismuth, 0.02 to 0.4 percent, by weight, of tellurium, and 0.02 to 0.4 percent, by weight, of selenium; and the remaining percent, by weight, of zinc, wherein the percent by weight of copper, silicon and phosphorous in the copper alloy satisfy the relationship $60 \leq X - 3Y + aZ \leq 70$, wherein X is the percent, by weight, of copper, Y is the percent, by weight, of silicon, Z is the percent, by weight, of phosphorous, and a is -3; and the copper alloy has a metal construction comprising multiple phases integrated to form a composite phase, wherein the composite phase is an α phase matrix having a total phase area comprising not more than 5% of a β phase, and 5-70% of the total phase area is provided by at least one phase selected from the group consisting of a γ phase, a κ phase, and a μ phase. This sixth copper alloy will be herein after called the "sixth invention alloy."

[0032] The sixth invention alloy has any one element selected from among 0.02 to 0.4 percent, by weight, of bismuth, 0.02 to 0.4 percent, by weight, of tellurium, and 0.02 to 0.4 percent, by weight, of selenium in addition to the components in the fifth invention alloy. The machinability is improved by adding, in addition to silicon and lead, any one element selected from among bismuth, tellurium and selenium as in the second invention alloy and the corrosion resistance and other properties are raised by adding at least one selected from among phosphorus, antimony and arsenic as in the fifth invention alloy. Therefore, the additions of copper, silicon, bismuth, tellurium and selenium are set at the same levels as those in the second invention alloy, while the additions of phosphorus, antimony, and arsenic are adjusted to those in the fifth invention alloy.

[0033] A free-cutting copper alloy also with an excellent easy-to-cut feature and with an excellent high strength feature and high corrosion resistance which is composed of 62 to 78 percent, by weight, of copper; 2.5 to 4.5 percent, by weight, of silicon; 0.02 to 0.4 percent, by weight, of lead; at

least one element selected from among 0.2 to 2.5 percent, by weight, of aluminum, and 0.02 to 0.25 percent, by weight, of phosphorus; and at least one element selected from among 0.7 to 3.5 percent, by weight, of manganese and 0.7 to 3.5 percent, by weight, of nickel; and the remaining percent, by weight, of zinc, wherein the percent by weight of copper, silicon, aluminum, phosphorous, manganese, and nickel in the copper alloy satisfy the relationship $60 \leq X - 3Y + aZ + bW + cV + dU \leq 70$, wherein X is the percent, by weight, of copper, Y is the percent, by weight, of silicon, Z is the percent, by weight, of aluminum, W is the percent, by weight, of phosphorous, V is the percent, by weight, of manganese, U is the percent, by weight, of nickel, a is –2, b is –3, c is 2.5, and d is 2.5, and the percent by weight of silicon, manganese and nickel satisfy the relationship $0.7 \leq Y/(V + U) \leq 6$; and the copper alloy has a metal construction comprising multiple phases integrated to form a composite phase, wherein the composite phase is an α phase matrix having a total phase area comprising not more than 5% of a β phase, and 5-70% of the total phase area is provided by at least one phase selected from the group consisting of a γ phase, a κ phase, and a μ phase. The seventh copper alloy will be hereinafter called the "seventh invention alloy."

[0034] Manganese and nickel combine with silicon to form intermetallic compounds represented by Mn_xSi_y or Ni_xSi_y, which are evenly precipitated in the matrix, thereby raising the wear resistance and strength. Therefore, the addition of manganese and nickel or either of the two would improve the high strength feature and wear resistance. Such effects will be exhibited if manganese and nickel are added in an amount not smaller than 0.7 percent by weight, respectively. But the saturation state is reached at 3.5 percent by weight, and even if the addition is increased beyond that, no proportional results will be obtained. The addition of silicon is set at 2.5 to 4.5 percent by weight to match the